

# Low GLM Detection Efficiencies in ~~Large~~ <sup>Western</sup> Storms

and

Comparison of the two GLMs

Ronald J Thomas, New Mexico Tech

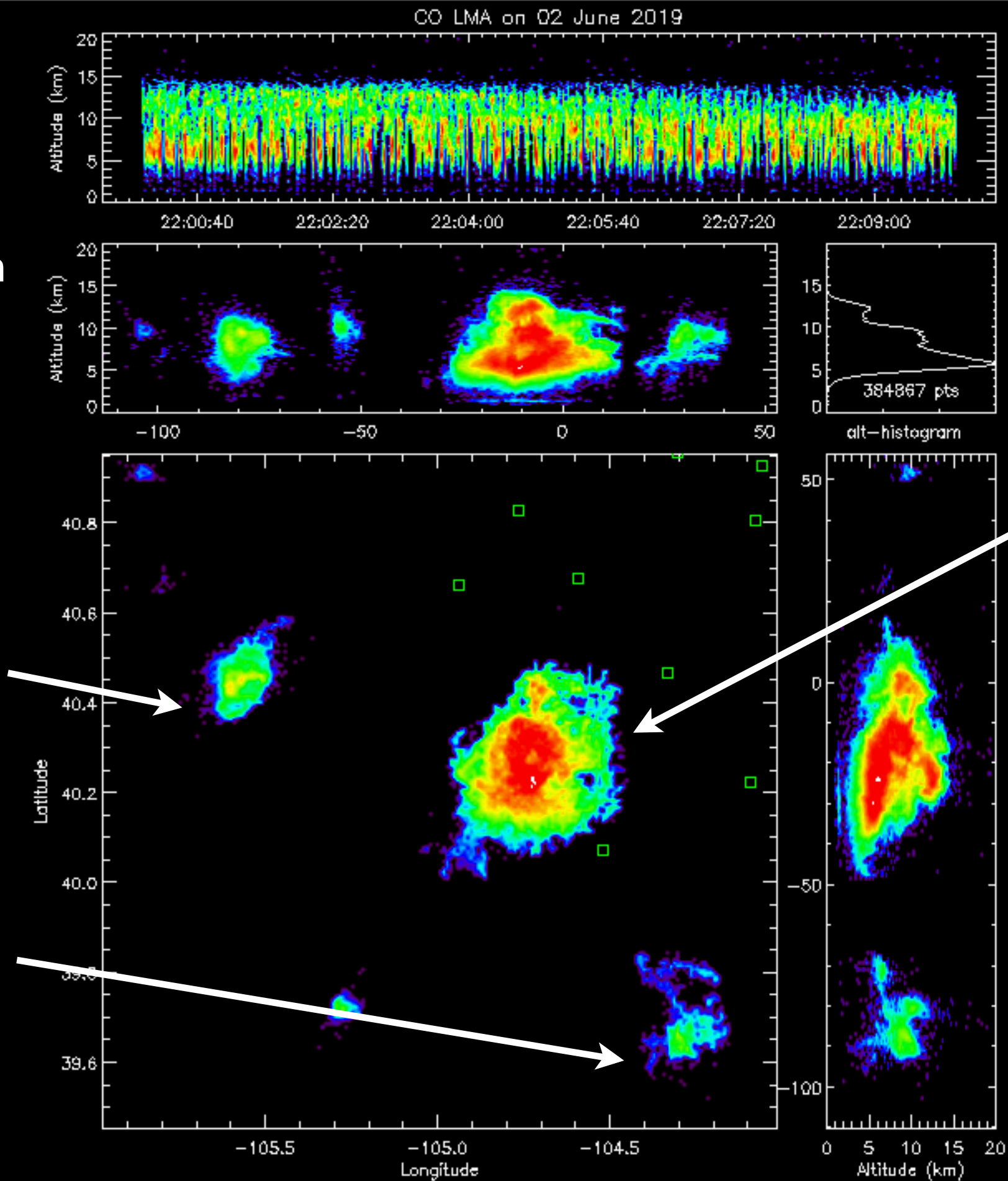
# Comparison of GLM to LMAs in Colorado and Utah

- The Colorado LMA is almost centered between the GOES West and East.
- Previously we have seen low DEs (20% or less) in storms over the Colorado LMA. The storms were mostly very large.
- Our LMA in central Utah is at a Cosmic Ray Observatory. It is a very dry region and the storm types contrast with thoes in Colorado.
- These measurements are from May and June 2019.

Colorado LMA  
thunderstorms on 2 June  
2019. Three storms each  
with different GLM detection  
efficiency

The west storm is inverted and the  
poorest detected.  
DE=7% GLM-West  
DE=6% GLM-East

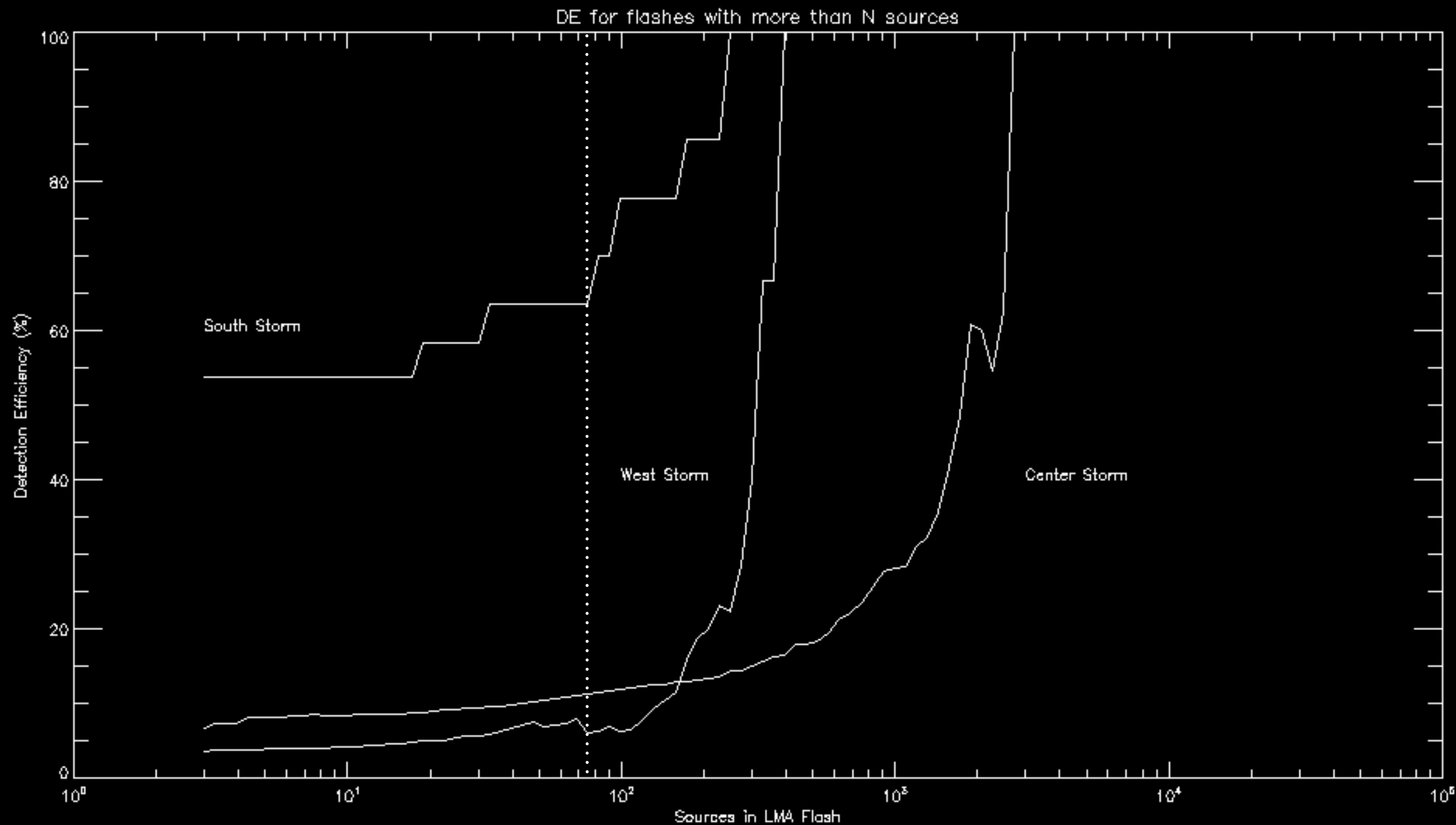
The south storm is normal polarity  
and the flashes are well detected.  
DE=64% GLM-West  
DE=60% GLM-East



Many , but not all the  
same flashes are detected  
by both GLMs

The center storm is much  
larger, inverted with  
multiple layers. The  
detection efficiency is poor  
DE=12% GLM-West  
DE=11% GLM-East

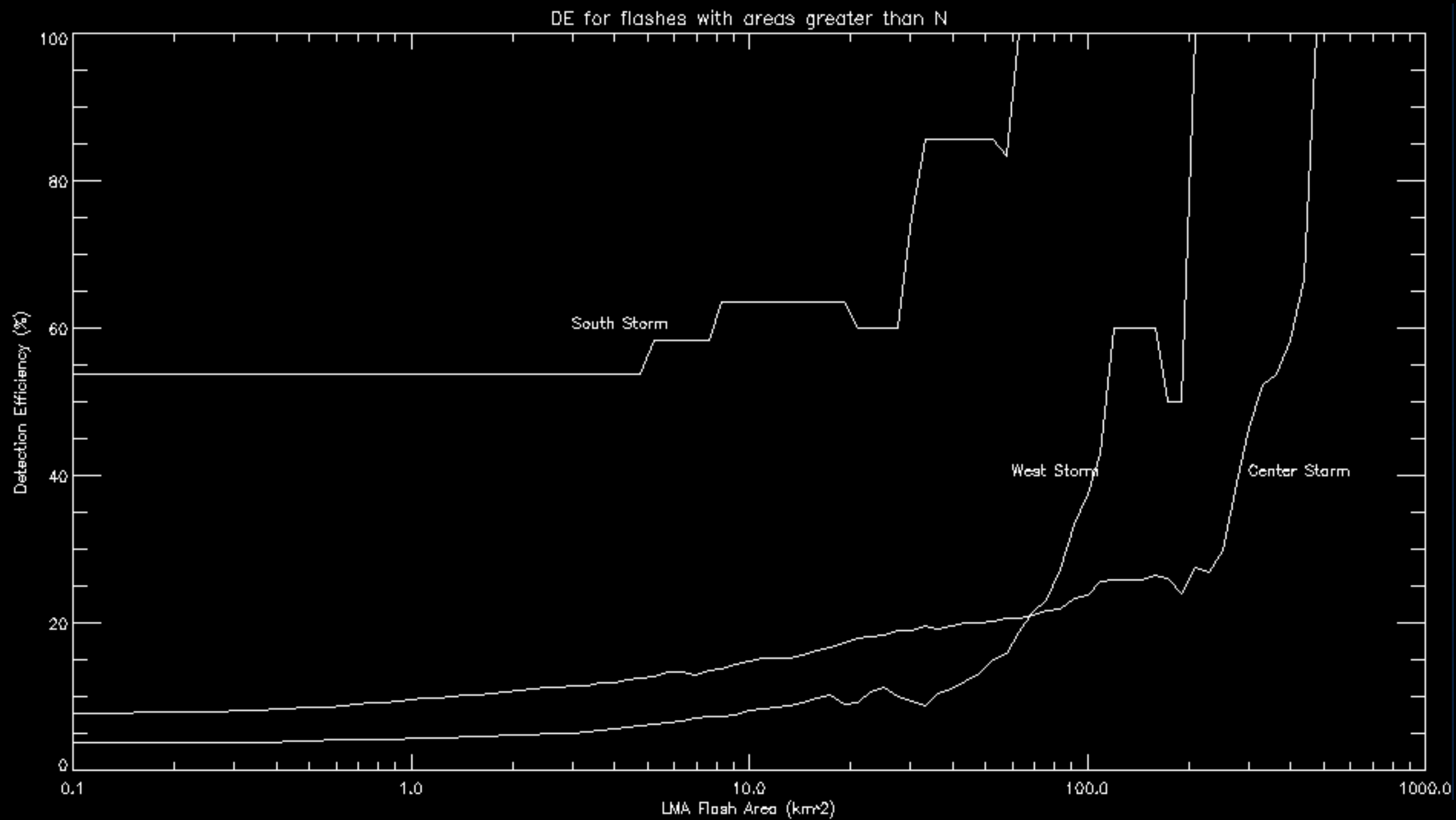
The detection  
efficiencies (DEs)  
for each storm  
by both GLMs is  
very close to the  
same



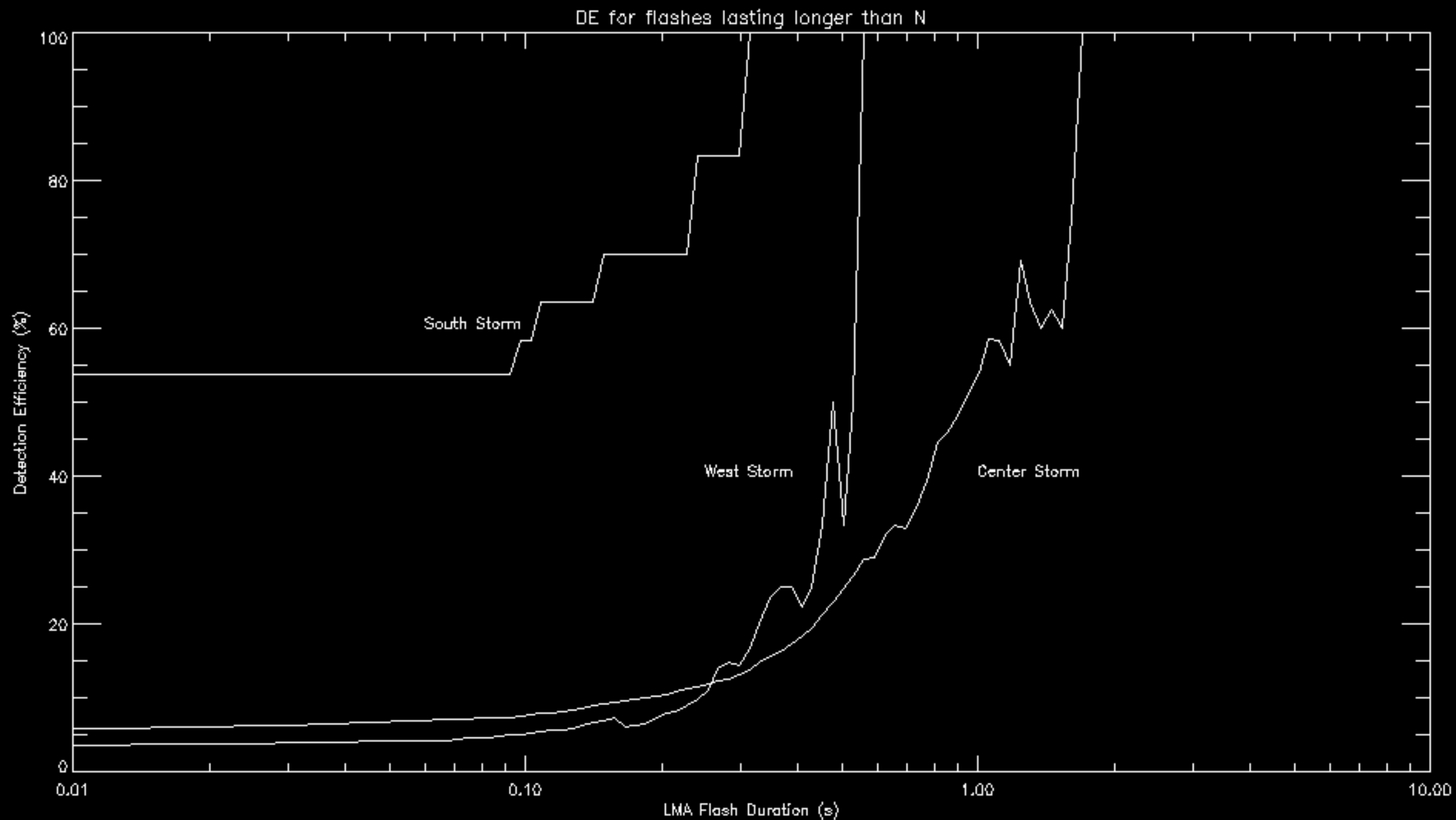
Increasing the size of the Ima flash to find the DE of 80% would leave only a few flashes in these storms.

In Florida storms we found that flashes with 75 Ima points or more were detected by GLM (80% DE).

The detection by GLM increases for largest flashes.  
I have used 75 points as a standard for finding DEs.

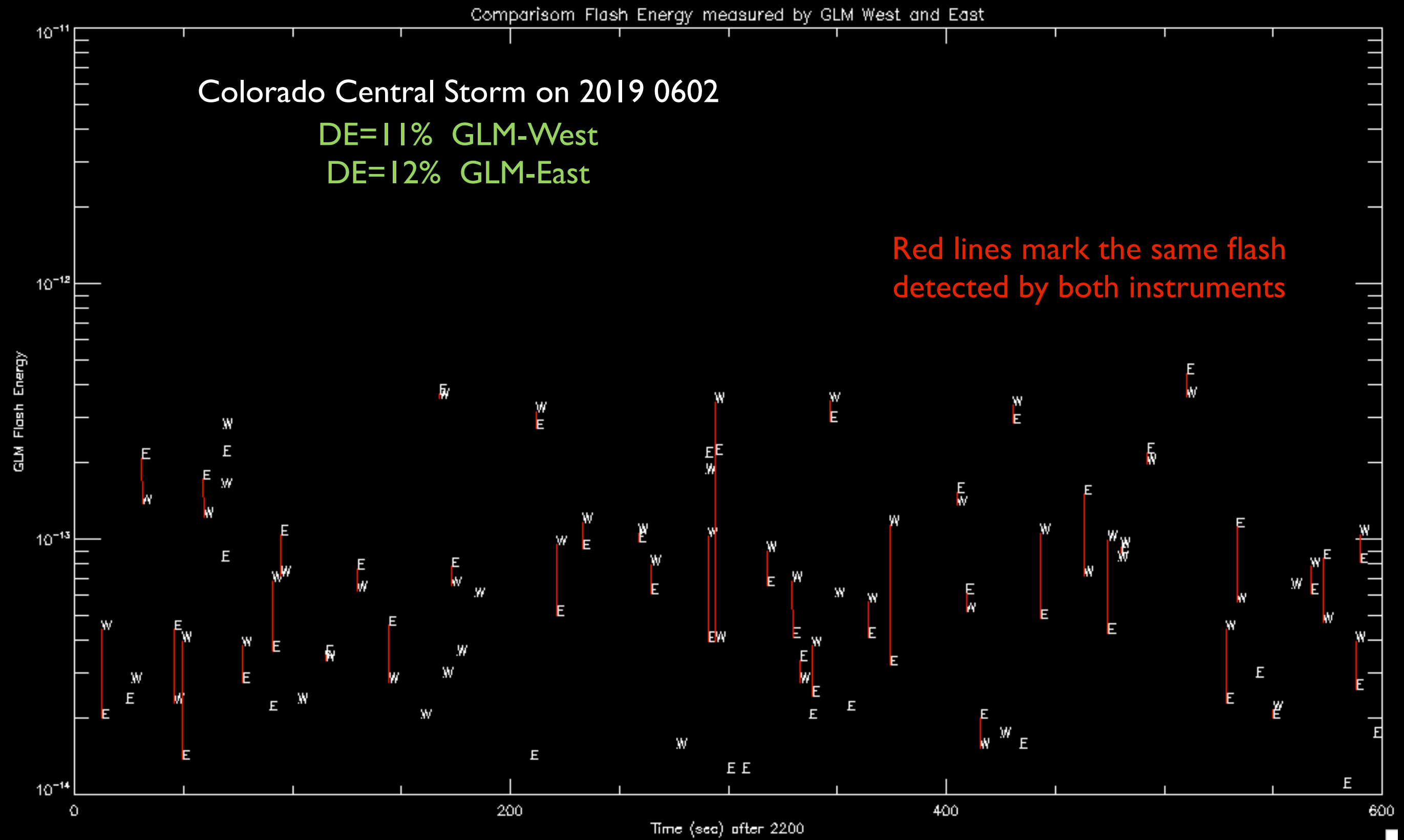


Detection efficiency also increases with lma flash area



Detection  
efficiency also  
increases with  
lma flash  
duration.

The Lightning and Atmospheric scatter is Different for each of these storms



# Moving to Utah



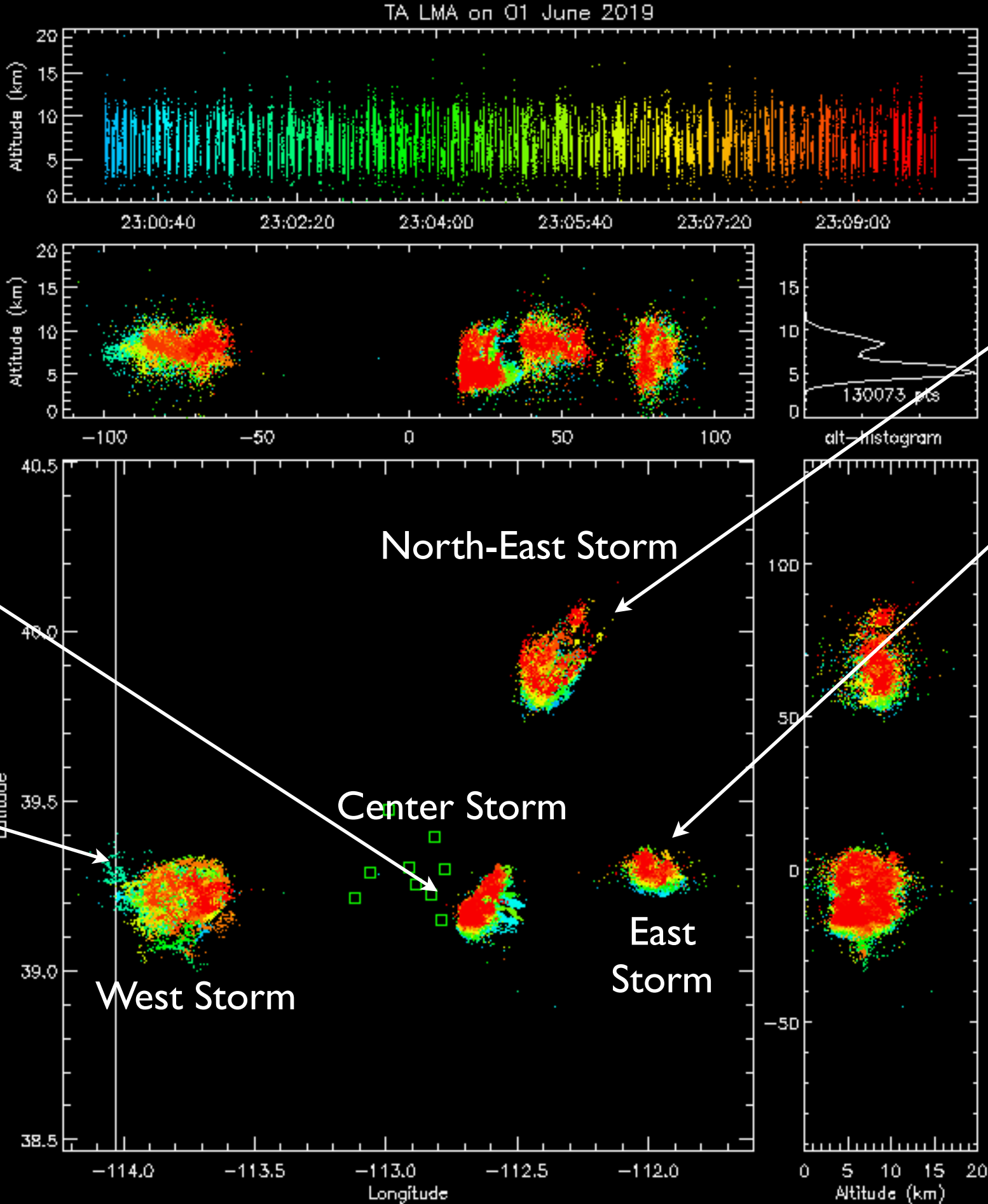
4 small Storms in Central Utah  
+  
2 GLM Instruments

What can we Learn?

Center Storm  
DE=34% GLM-West  
DE=10% GLM-East

West Storm  
DE=79% GLM-West  
DE=48% GLM-East

Are the differences due to:  
Instrument differences?  
Storm and Lightning differences?  
Atmospheric Differences?



North-East Storm  
DE=59% GLM-West  
DE=32% GLM-East

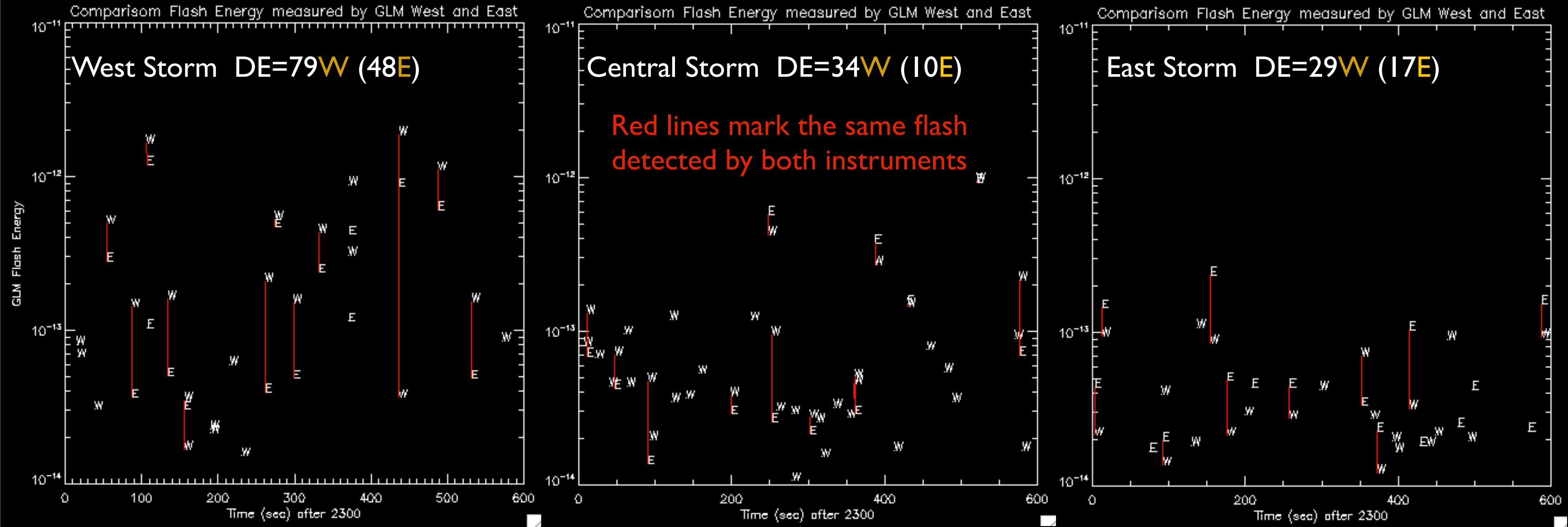
East Storm  
DE=29% GLM-West  
DE=17% GLM-East

GLM-West should be better as  
These storms are  
24 deg from GLM-WEST and  
38 deg from GLM-East.  
Off-axis band-pass filter  
Longer slant path in Atmosphere

The Colorado storms had very  
similar DE and were centered  
between the GLMs

The story is more complex

# Compare Energy measures by GLM West and East for three Storms



In the west storm  
the west GLM sees  
more energy in the  
flashes

In the east storm  
the east GLM sees  
more energy

In the center and east  
storms the average energy  
is lower than west storm  
by about 10X

Larger detected energies go with higher DEs

The change in ratio of the energy  
measured by each instrument  
(about 10X) must be due to local  
visibility conditions, not to the  
differences between the  
instruments.

Back to Colorado

# 4 Small storms in Colorado

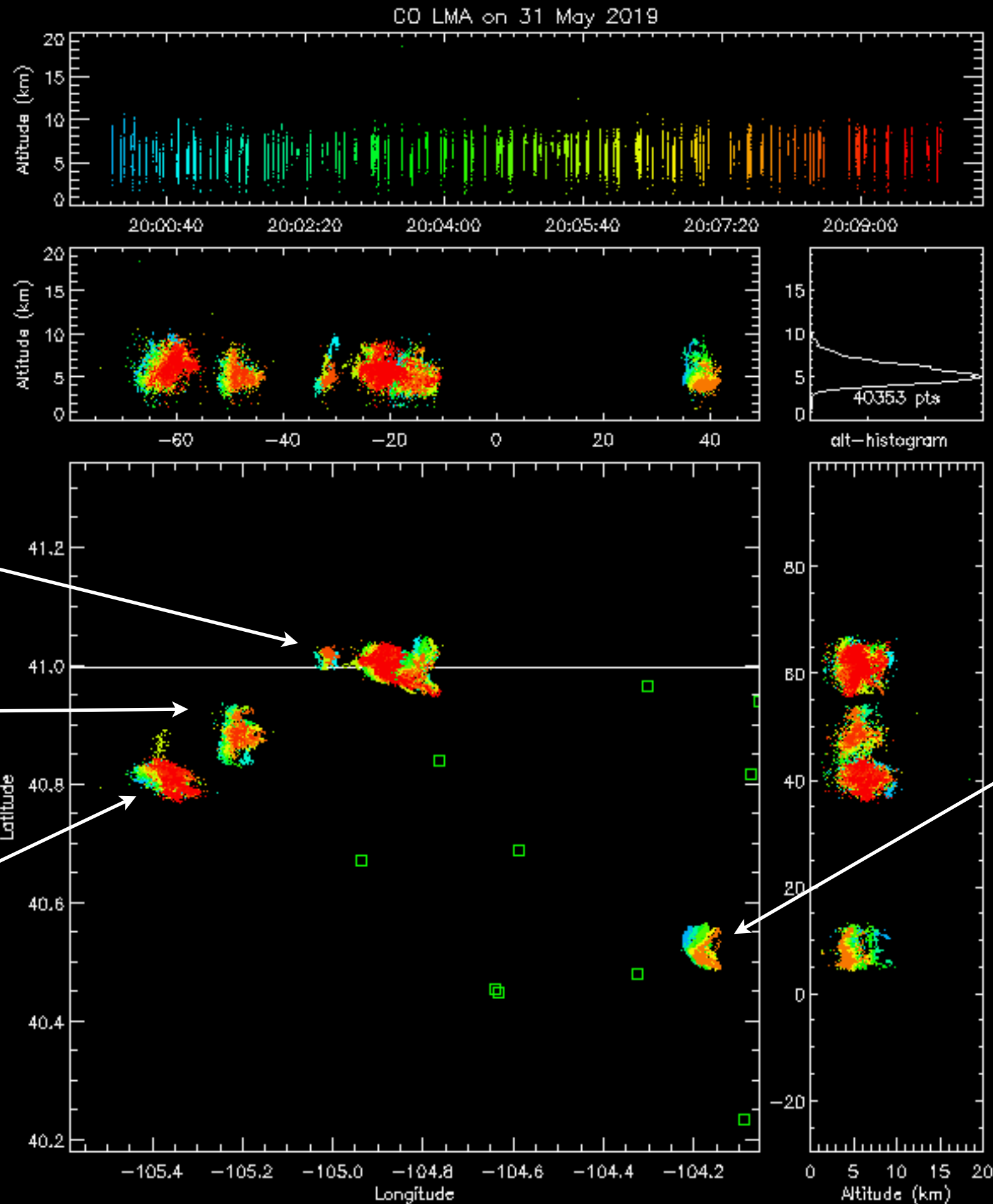
These storms have Negative layer over a Positive layer

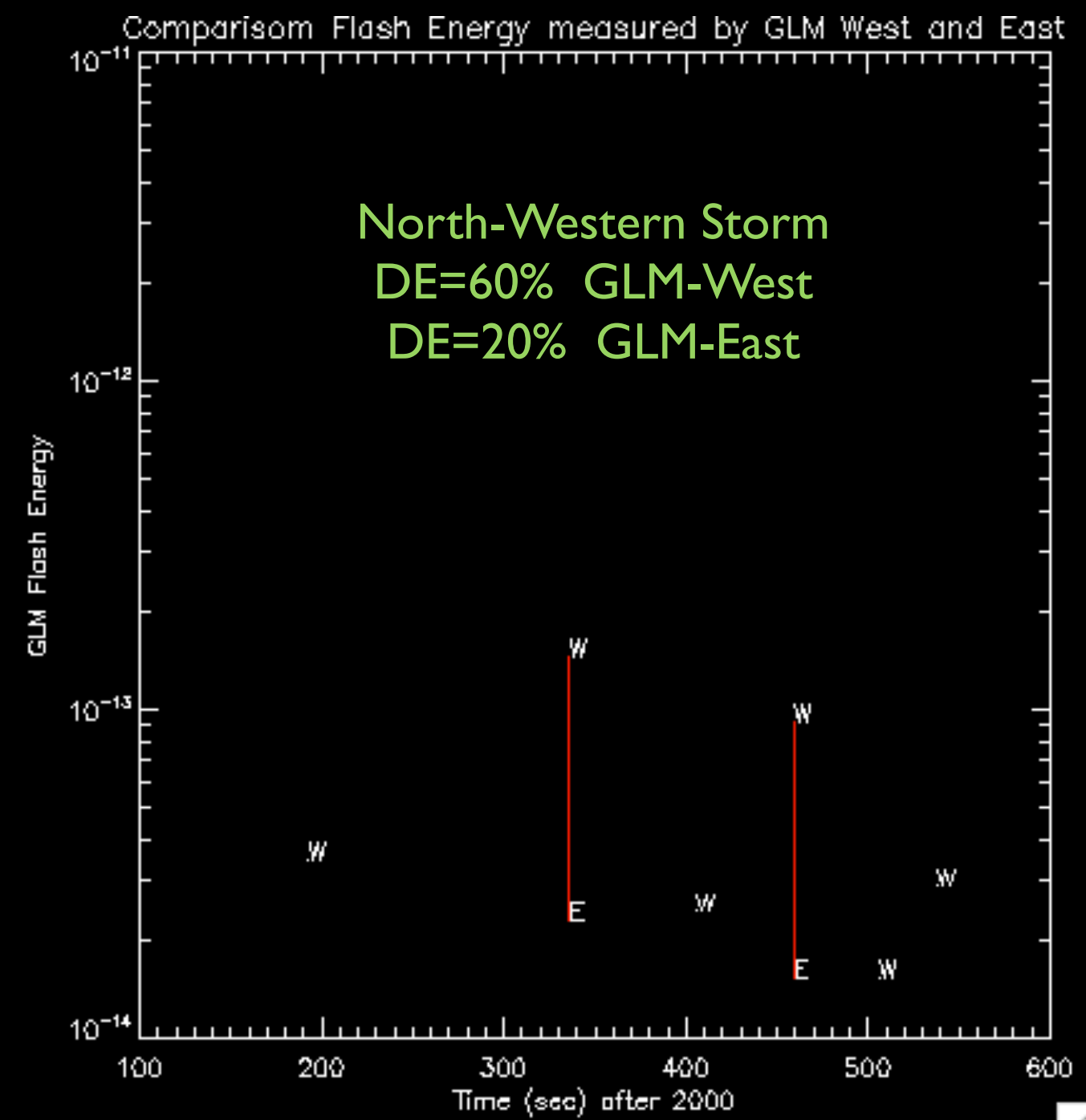
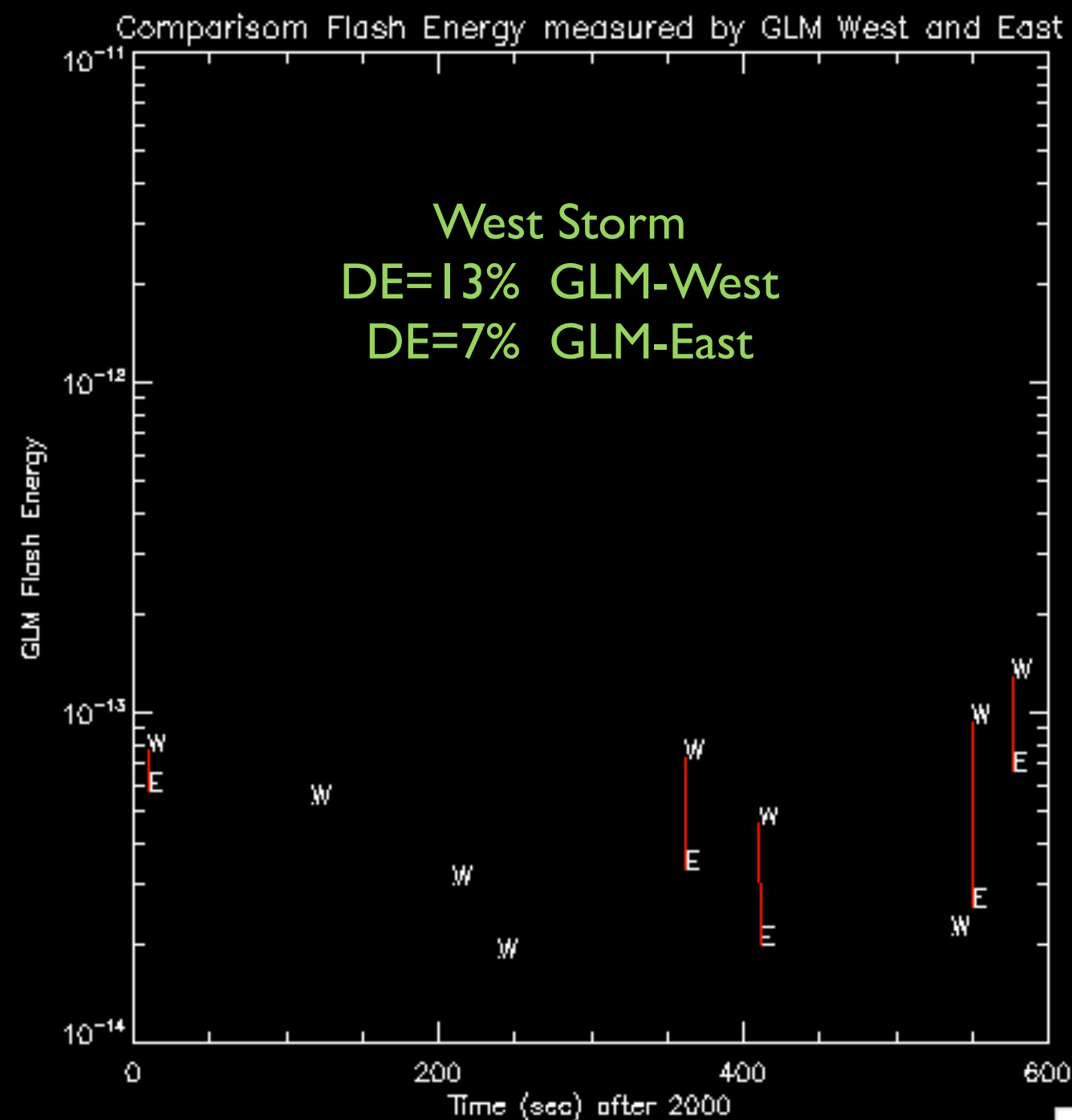
North storm  
DE=39% GLM-West  
DE=28% GLM-East

North-Western Storm  
DE=60% GLM-West  
DE=20% GLM-East

West Storm  
DE=13% GLM-West  
DE=7% GLM-East

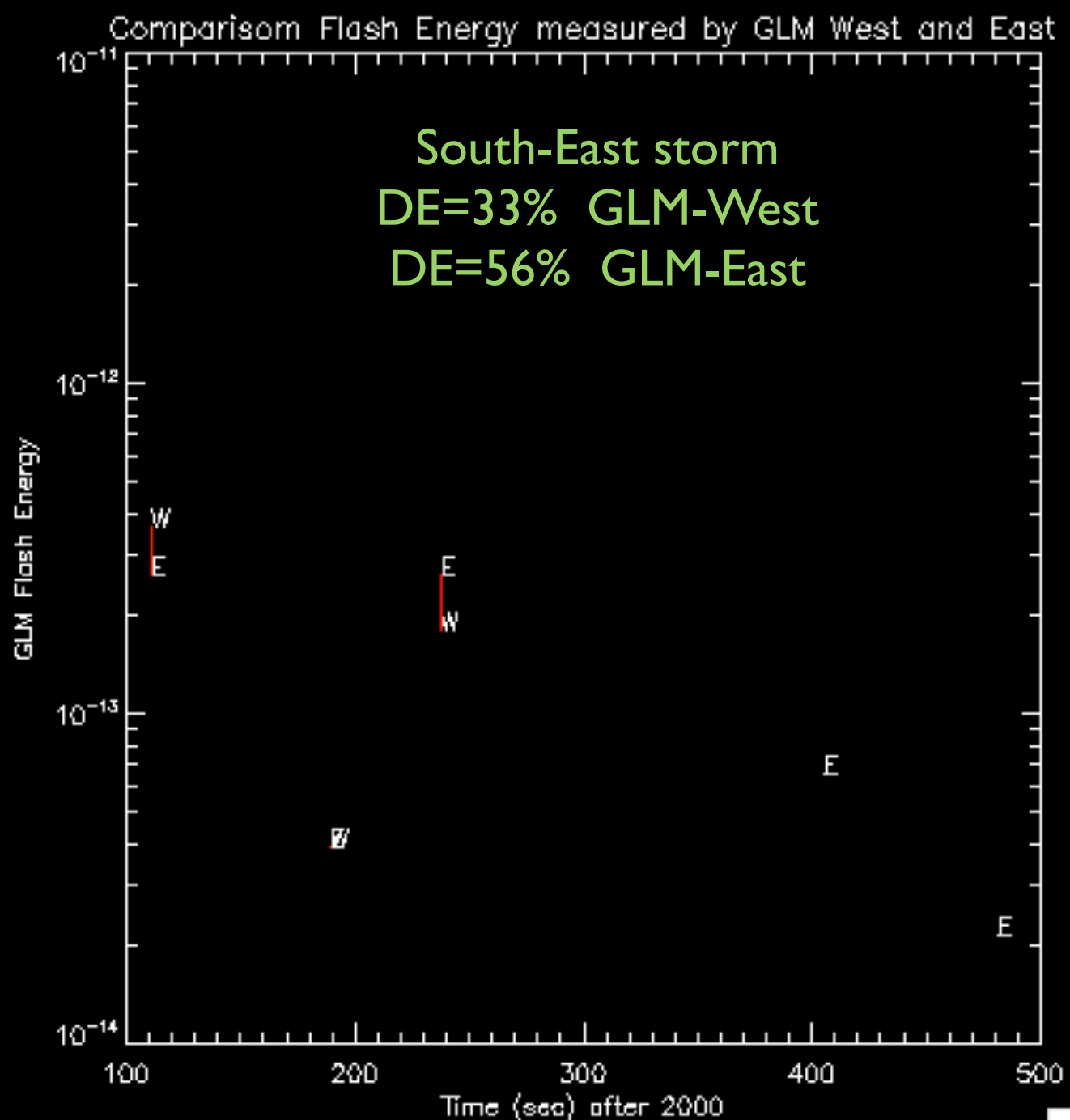
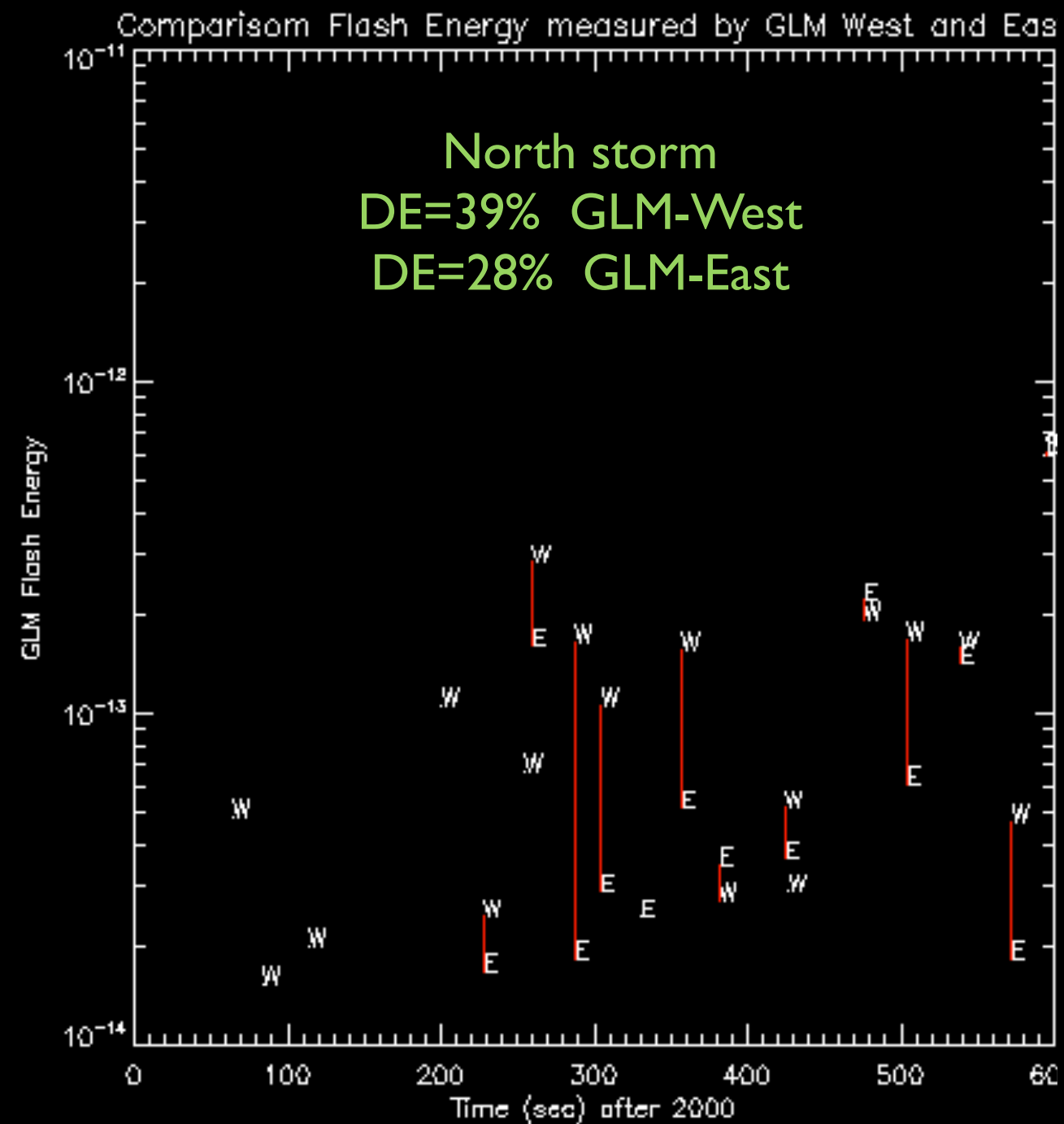
South-East storm  
DE=33% GLM-West  
DE=56% GLM-East





In the three northern storms the western GLM has a higher DE and the measured flash energies are larger.  
There maybe scattering layers reducing the light going east, perhaps an anvil.

When the timing and positional information agree the groups could be combined into new flashes.



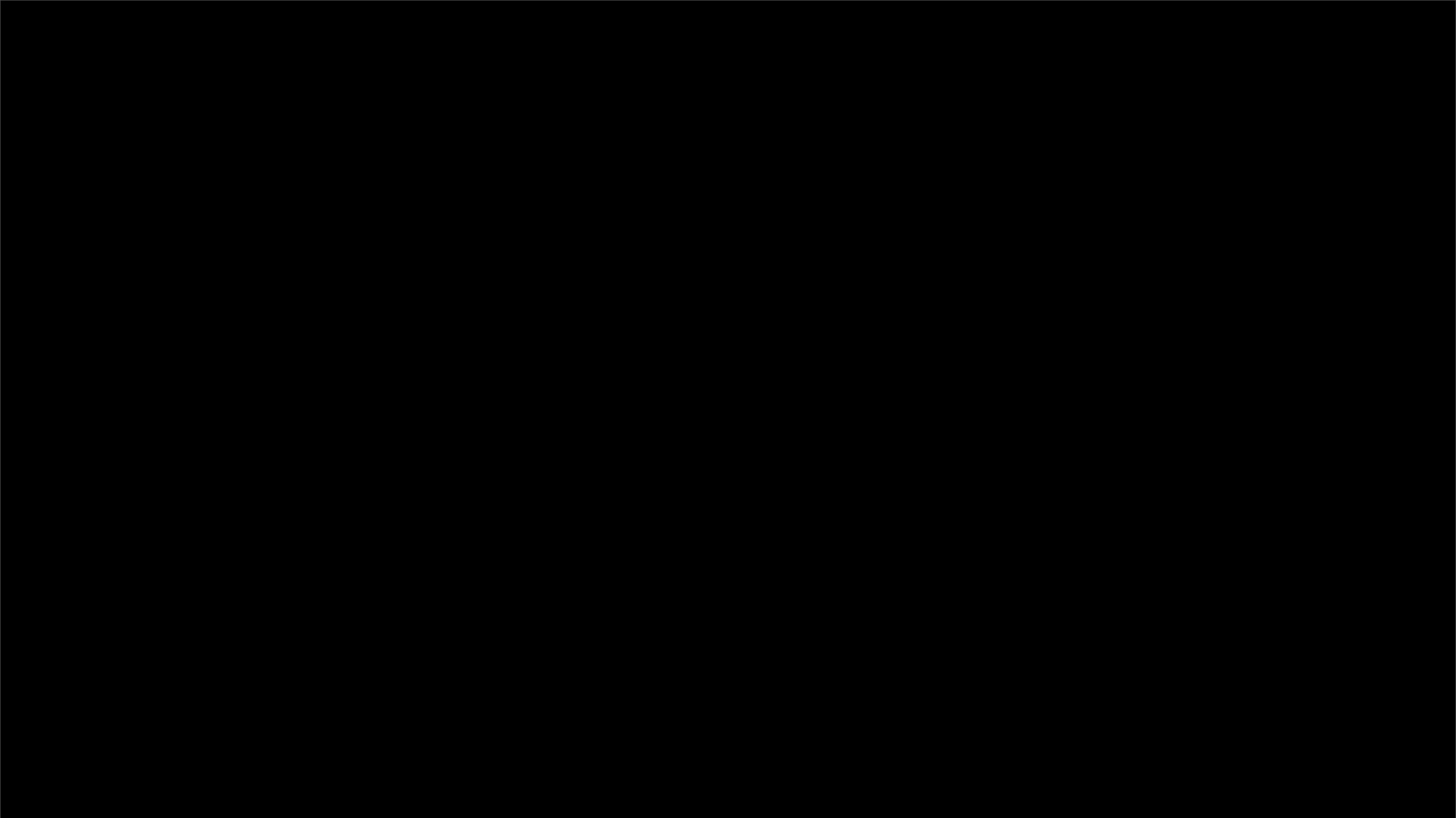
In the three northern storms the western GLM has a higher DE and the measured flash energies are larger.

The Eastern GLM see 5 flashes in the southern storm, but the measured energies are similar.

When the timing and positional information agree the groups could be combined into new flashes.

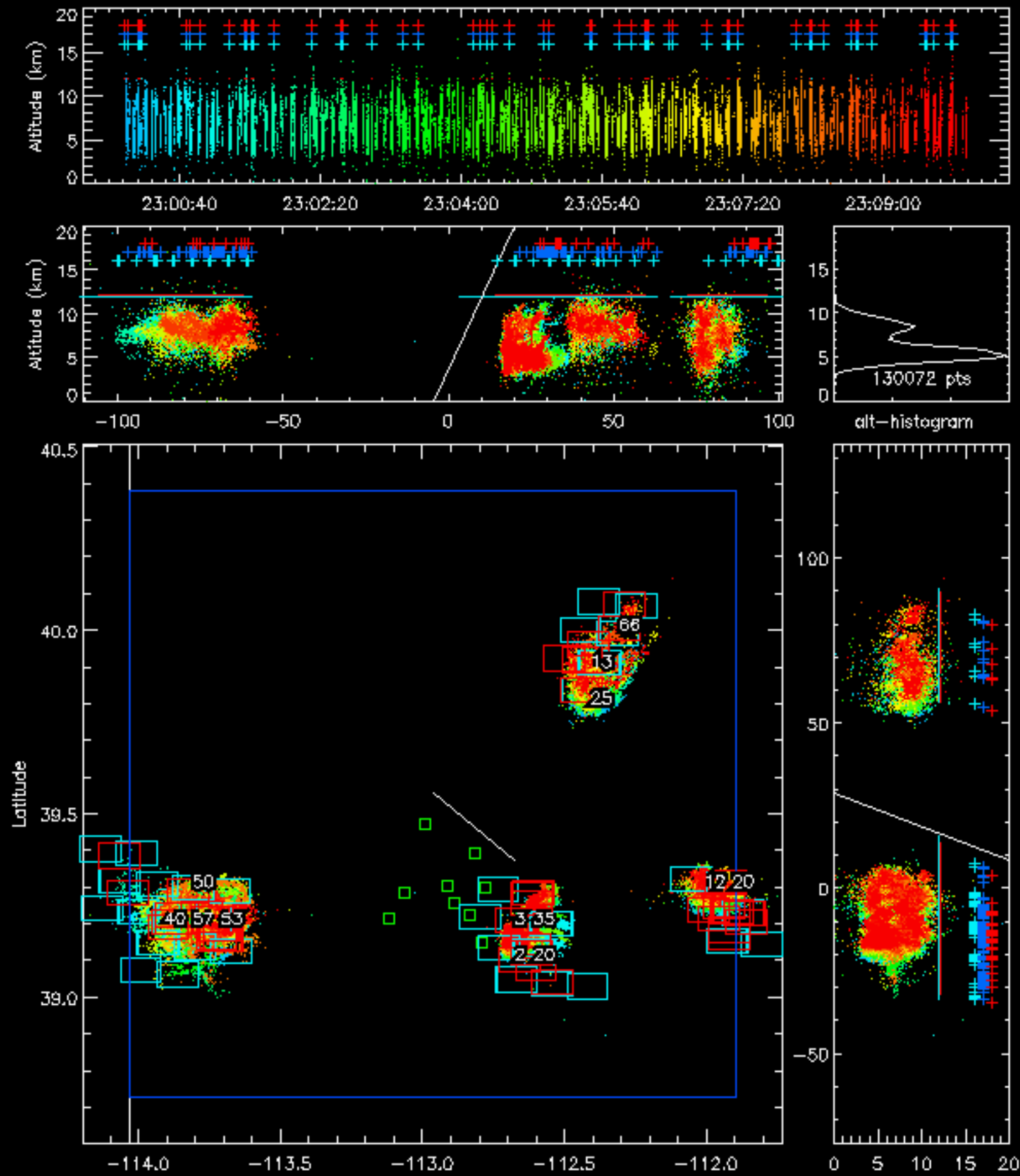
# Conclusions

- Lightning in Most Storms in Colorado and Utah are poorly detected by both GLM instruments. Many substantial flashes are missed.
- In a few storms the detection rate was over 60%
- We only checked a small amount of data but these findings are very similar to previous results from GLM-I6
- The detection rate and measured flash energy are correlated and indicate that as conditions change, a different fraction of the light reaches the GLMs.





TA LMA on 01 June 2019



CO LMA on Q2 June 2019

